EXHIBIT C

KC ENGINEERING, P.C.
4300 S. LAKEPORT
SIOUX CITY, IOWA 51106

DATE: August 28, 2012

TO: Mr. Chad Kramer
Sioux Steel Company
196 ½ E 6th Street
Sioux Falls, SD 57101

RE: Engineering Analysis and Design Review of 18' Diameter and 30' Diameter Hopper Cone Assemblies

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Dear Mr. Kramer,

Per your request, KC Engineering has performed a structural engineering evaluation on the 18' Diameter and 30' Diameter Hopper Cone designs provided to us. Through the use of the structural analysis program RISA 3D and manual calculations, we have come to the conclusion that the 18' Diameter Hopper will sufficiently and efficiently support the expected loads however, the 30' Diameter Hopper ***is not*** sufficient as designed.

Hopper Description

The 18' Diameter Hopper Cone assembly consists of twelve W8x13 columns with the bin stiffeners sitting directly on these columns. This hopper has a ¼" Grade 50 ksi steel compression ring stiffener and the frame is braced by 2.5"x1.0"x12 Gage Channels in both the horizontal and diagonal directions. The hopper cone itself is 14 Gauge Grade 50 ksi galvanized steel.

A larger 30' Diameter Hopper Cone assembly consists of twelve W8x28 columns with the bin stiffeners also sitting directly on these columns. This hopper has 5/16"x 8" deep compression ring channels attached to 5/16" Plates for the compression ring weldment. The frame is braced by 12 Gage Channels with the horizontal bracing and diagonal cross-bracing both being 2½" deep. The hopper cone is 10 Gauge Grade 50 ksi galvanized steel.

Analysis

The analysis on the frames was done using ASCE 7-05 load combinations and bin eave heights provided in emails from Sioux Steel dated July 17, 2012 and August 2, 2012. The following loads were used in the analysis:

Frame Self-weight:	Calculated by RISA
Bin Dead Load:	6 psf
Snow Load:	10 psf
Wind Load:	≈ 19 psf (Varies by Height)
Grain Wall Load:	47 (As Stiffener Loads)
Grain Hopper Pressures:	Varies per Depth

Kramer
Exhibit No. 9
Date: 4-19-16
Audrey M. Barbush, RPR

The grain loads were calculated and evaluated in accordance with *Design of Steel Bins for Storage of Bulk Solids* (Gaylord, 1984) and *ANSI/ASAE EP433 – Loads Exerted by Free-Flowing Grain on Bins* (1998). In the attached pages, the load cases and load combinations are shown in more detail for both hoppers. The attached pages also include detailed information for all of the members and plates.

Conclusions

After completing the RISA model and hand calculations, the controlling combination for the hopper and frame analysis is Load Combination #2 (DL+LL). This combination controls for both the column design and the hopper plates. All of the members and plates for the 18' Diameter Hopper fell within the acceptable material limits for each member. However, the columns for the 30' Diameter Hopper were ***found to be overstressed by a factor of 1.37*** and should be replaced with larger columns. The calculations for these columns can be found on Pages 20-21 of the report for the 30' Diameter Hopper.

A maximum base reaction summary can be found on Pages 519 and 664-665 in the 18' and 30' Diameter Hopper Reports, respectively.

We appreciate the opportunity to provide our services to you on this project. If you have any questions, please contact me at (712) 252-2100.

Respectfully submitted,

Derek Matthies

Derek Matthies, EI
KC Engineering, P.C.

Reviewed by:

Jason P. O'Mara
Vice President
KC Engineering, P.C.

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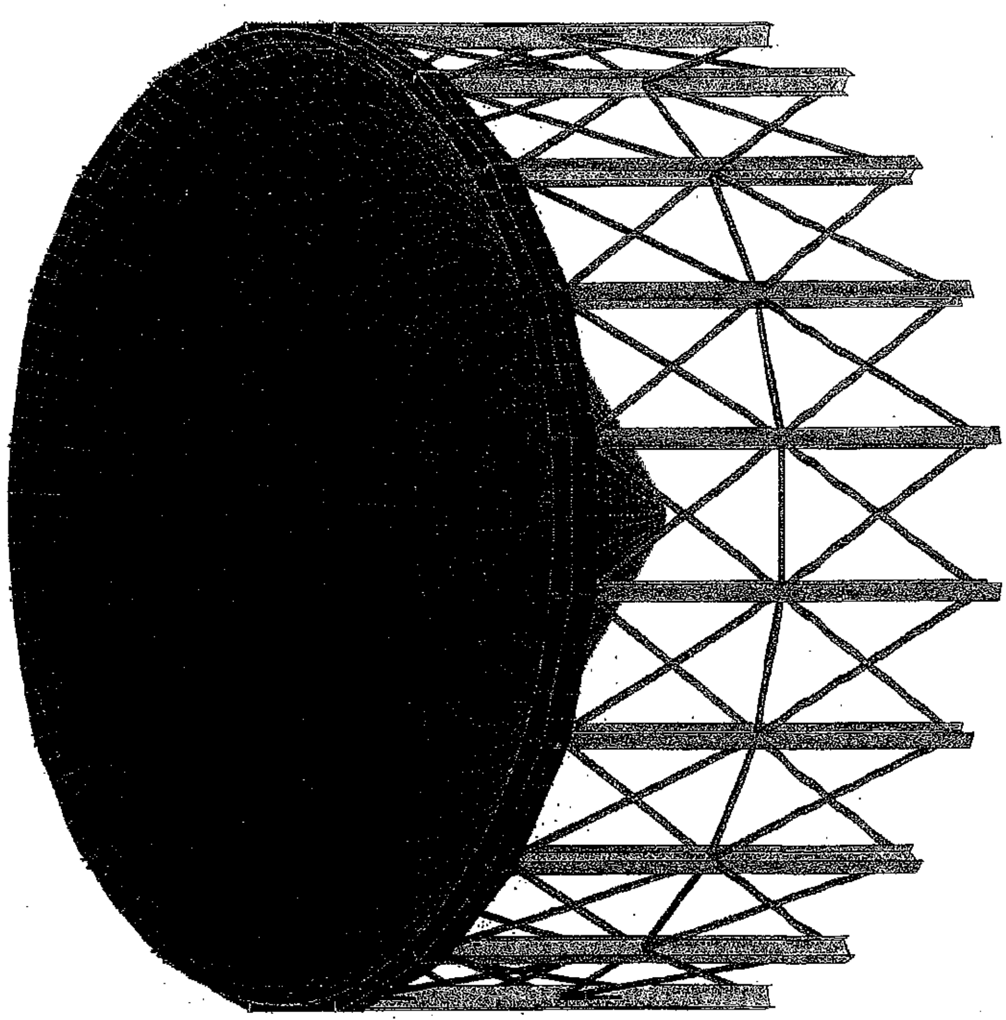

Sioux Steel	30' Diameter Hopper	SK - 1
DJM		Aug 13, 2012 at 4:23 PM
61165		30' Diameter Hopper Cone2.r3d

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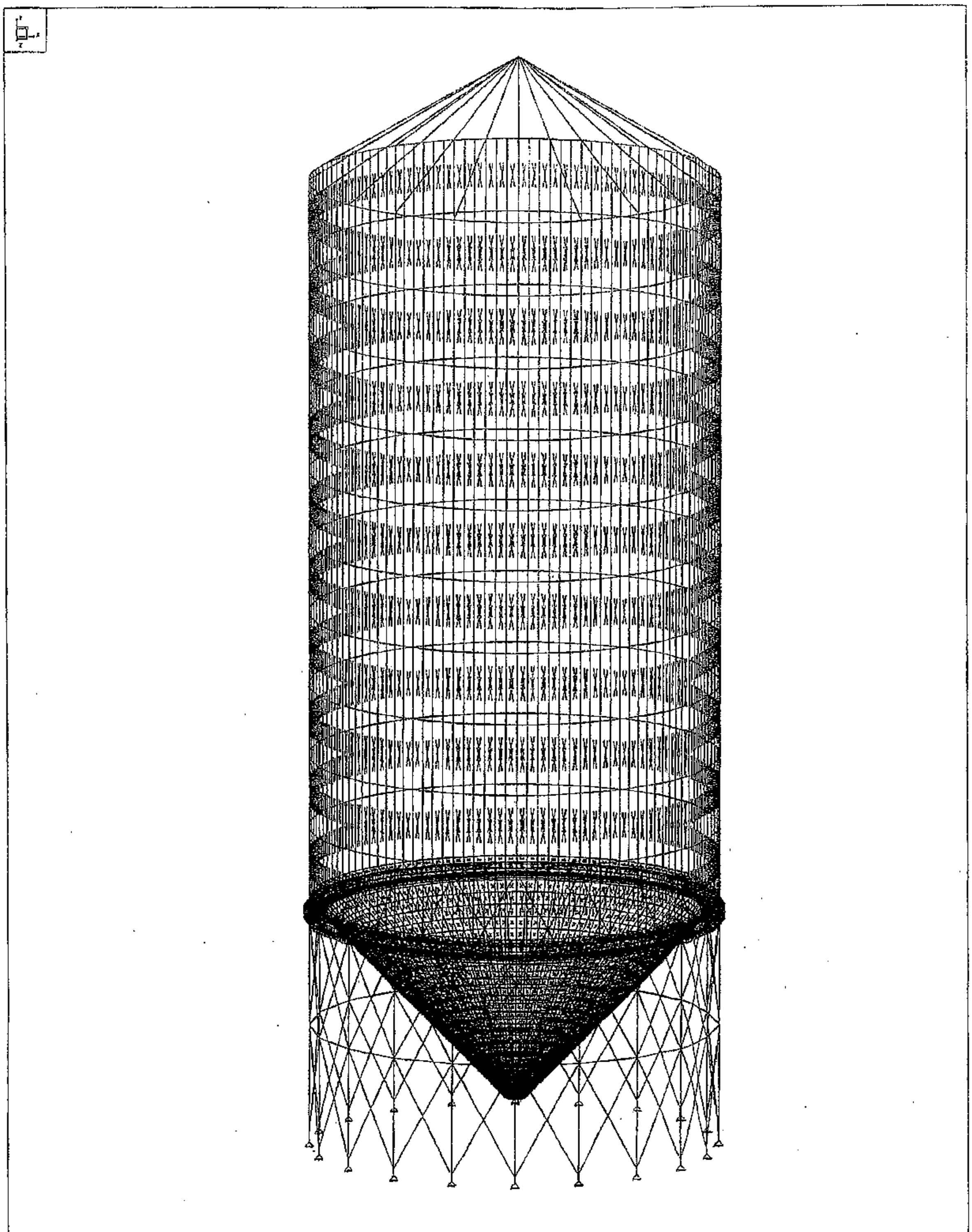

Sioux Steel	30' Diameter Hopper	SK - 1
DJM		Aug 13, 2012 at 4:21 PM
61165		30' Diameter Hopper Cone2.r3d

KC ENGINEERING CO.
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Fax 252-0346

PROJECT NAME: 30' Φ Hopper Analysis	PAGE 1 OF 6	DATE: 8/8/12
LOCATION: Sioux Steel	PROJECT #: 61165	
SUBJECT: Loads	DESIGNER: DM	

1. Bin Dead Load

$P_s \approx 6$ psf

A. Roof:

$SA = \pi r d + \pi r^2 = \pi(15')(17.32') + \pi(15')^2 = 1523\ ft^2$

where $d = \frac{15}{\cos 30} \approx 17.32'$

$P = 6psf\ (1525\ ft^2) = 9{,}150\ \underline{lbs}$

B. Bin:

$SA = \pi D H = \pi(30)(51.33') = 4837.74\ ft^2$

$P = 6psf\ (4837.74\ ft^2) = 29{,}026.4\ lbs$

Total $\rightarrow \frac{9150 + 29026}{20\ \text{stiffeners}} = \underline{\underline{1.91\ K/\text{stiffener}}}$

2. Snow Load

$P_s = C_s\,[0.7\,C_e C_t I\, P_g]$

$C_s = 0.5$ $\qquad I = 0.8$

$C_e = 1.0$ $\qquad P_g = 30\ psf$

$C_t = 1.2$

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SUBJECT: Loads	DESIGNER: DM	

$P_s = 0.5[0.7(1.0)(1.2)(0.8)(30psf)] = 10.08$ psf

$P = 10.08$ psf $(1523 ft^2) = 15,352$ lbs

Total → $\frac{15,352^{lb}}{20 \text{ Stiffeners}} = \underline{0.77 \frac{Kip}{Stiffener}}$

3. Wind Load

$q_z = 0.00256 K_z K_{zt} K_d V^2 I$

$K_z = 1.12$ (For $h_{mean} = 55.7'$)

K_z = Varies Per Bin Height

$K_{zt} = 1.0$

$K_d = 0.95$ (Tanks)

$V = 90$ mph

$I = 0.87$

$q_z = 17.14 K_z$ psf

$q_h = 19.20$ psf

$C_F = 0.712$ (Windward Bin Wall)

$C_p = -0.18$ (Windward Roof edge)

$C_p = +0.2$ (Windward Roof Middle)

$C_p = -0.7$ (Leeward Roof Edge

$C_p = -0.6$ (Leeward Roof Middle)

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PROJECT NAME: 30' Φ Hopper Analysis	PAGE 3 OF 6	DATE: 8/8/12
LOCATION: Sioux Steel	PROJECT #: 61/65	
SUBJECT: Loads	DESIGNER: DM	

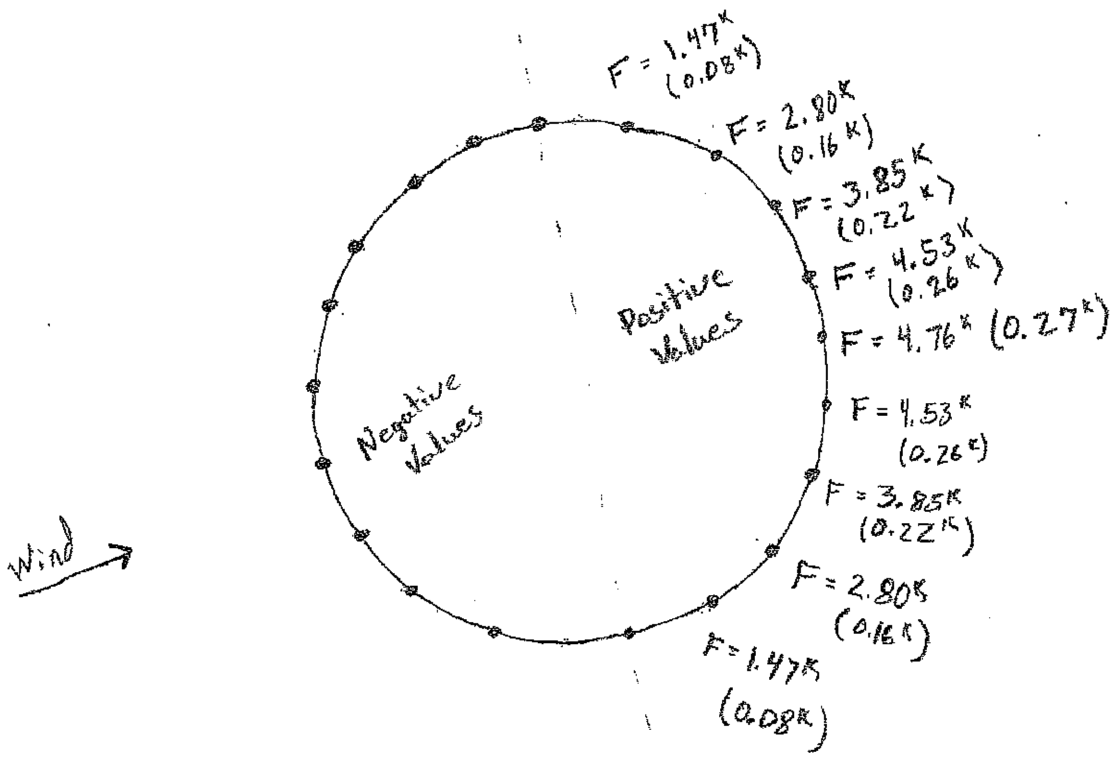
A. Max Overturning Moment of Bin = 714 ^1-K

Max Wind Shear of Bin = 18.7 ^Kips

B. Max Overturning Moment of Hopper + Frame = 40.64 ^1-1

Max Wind Shear of Hopper + Frame = 4.51 Kips

Wind Loads



* Frame/Hopper Loads in Parentheses

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PROJECT NAME: 30' Φ Hopper Analysis | PAGE 4 OF 6 | DATE: 8/8/12
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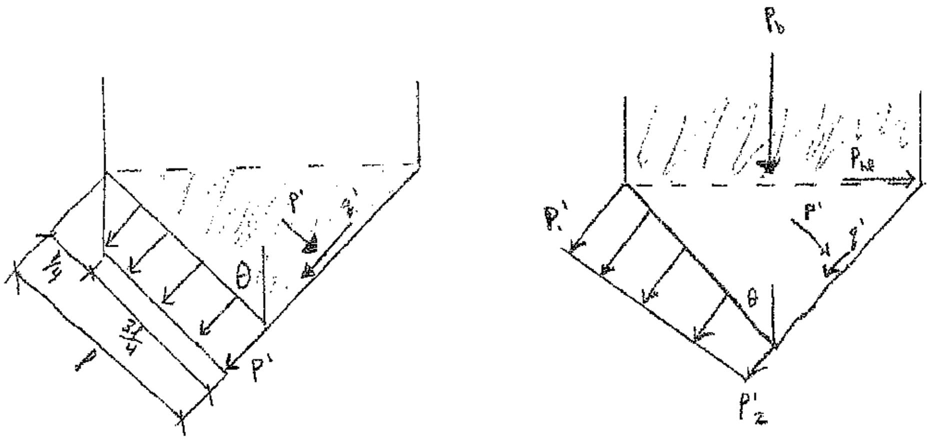
SUBJECT: Loads | DESIGNER: DM

4. Grain Pressures (Full Bin)



(a) (b)

A. Pressures from material in hopper (Figure a)

$$P' = \frac{0.6\,\gamma K D \cos^2\theta}{\sqrt{\mu'}} = \frac{0.6\,(55.3\,\tfrac{lb}{ft^3})(0.5)(30')\cos^2(45)}{\sqrt{.37}}$$

$$\underline{P' = 409\text{ psf}}$$

$$q' = \frac{P'}{2} = \frac{409}{2} = \underline{205\text{ psf}}$$

B. Pressures from the material above the hopper (Figure b)

$$P_1' = \frac{P_b \sin^2\theta + P_{ht}\cos^2\theta}{\sqrt{\mu'}}$$

$$P_2' = P_b \sin^2\theta$$

$$q' = \frac{P'}{2}$$

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PROJECT NAME: 30' Φ Hopper Analysis		PAGE 5 OF 6	DATE: 8/8/12
LOCATION: Sioux Steel		PROJECT #: 61165	
SUBJECT: Loads		DESIGNER: DM	

where $P_b = V_{max} = 1650$ psf

$P_{hf} = V_{Smax} = 825$ psf

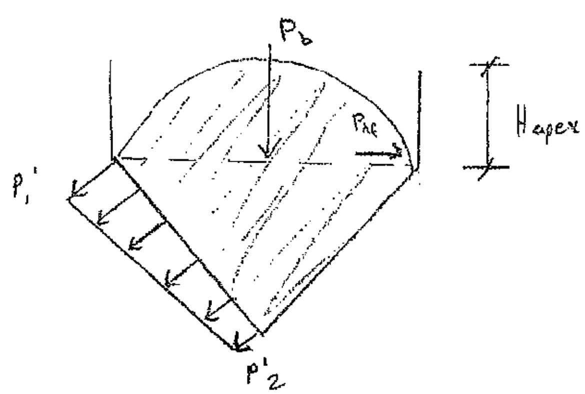
$$P_1' = \frac{(1650\,psf)\sin^2(45) + (825\,psf)\cos^2(45)}{\sqrt{.37}} = \underline{2034\ psf}$$

$$P_2' = P_b \sin^2\theta = (1650\,psf)\sin^2(45) = \underline{825\ psf}$$

$$q' = \frac{1631}{2} = \underline{815\ psf}$$

$$P' = \tfrac{2}{3}(2034 - 825) + 825 = 1631\ psf$$

5. Grain Pressures (Empty Bin/Full Hopper)



(c)

$H_{apex} = \frac{D}{2}\tan\alpha$ where: repose angle $\alpha = 23°$

$H_{apex} = \frac{30'}{2}\tan 23° = 6.37'$

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PROJECT NAME: 30' ϕ Hopper Analysis	PAGE 6 OF 6	DATE: 8/8/12
LOCATION: Sioux Steel	PROJECT #: 61165	
SUBJECT: Loads	DESIGNER: DM	

A. Pressures from material in hopper (Figure a)

$$p' = 409 \text{ psf}$$
$$q' = 205 \text{ psf}$$
> same as Page 4

B. Pressures from the material above the hopper (Figure c)

$$P_b = \left[\frac{1}{3}\pi r^2 h\right]\frac{\gamma}{\pi r^2} = \left[\frac{1}{3}(6.37')\right]55.3\frac{lb}{ft^3} = 117.4 \text{ psf}$$

$$P_{hf} = K(P_{bmax}) = 0.5(117.4) = 58.7 \text{ psf}$$

$$P_1' = \frac{(117.4\text{ psf})\sin^2(45) + (58.7\text{ psf})\cos^2(45)}{\sqrt{.37}} = \underline{144.8 \text{ psf}}$$

$$P_2' = 117.4\sin^2 45 = \underline{58.7 \text{ psf}}$$

$$q' = \frac{116.1}{2} = \underline{58.1 \text{ psf}}$$

$$P' = \frac{2}{3}(144.8 - 58.7) + 58.7 = 116.1 \text{ psf}$$

6. Grain Wall Load

$P = P_{vmax}(D')$ where D' = distance btwn stiffeners

$$P = 10{,}020 \text{ plf } (4.75') = \underline{\underline{47.6 \text{ Kips}}}$$

KC Engineering, P.C.

Project Name: 30' Diameter Hopper Analysis		Date:	8/8/2012
Location: Sioux Steel		Project #:	61165
Subject: Grain Pressures and Wall Loads - 30' Diameter Hopper		Designer:	DJM

Calculate Grain Pressures and Wall Loads on a Circular Steel Bin using ANSI/ASAE EP433:

Note: This spreadsheet and ASAE EP433 shall to be used only for the design of foundations for steel bins. Concrete silos shall be designed using ACI 313 with conservative modifications in accordance with the Midwest Plan Service handbook and shall not be designed using this spreadsheet.

Input Variables for use in Janssen's Formula:

bulk density of grain, W =	55.3 pcf	use 48 for corn or beans, < or = 52 for any grain
emptying angle of internal friction, ϕ =	27 degrees	use 27 for shelled corn, 29 for soybeans
filling angle of repose, α =	23 degrees	use 23 for shelled corn, 25 for soybeans
coefficient of friction of grain on wall, μ =	0.37	use 0.3 for smooth steel, 0.37 for corrugated steel
k =	0.50	always use 0.5 when using ASAE EP433
Diameter of Tank, D =	30 ft	
Hydraulic Radius of Tank, R =	7.5 ft	
height of grain at wall, Hs =	51.3 ft	

Calculate grain heights, determine whether bin is deep or shallow, and calculate Overpressure Factor, F:

height to top of grain at apex, Ht =	57.7 ft	
height of grain to 1/3 height of surcharge, H =	53.5 ft	
height at which rupture plane intersects =	24.5 ft	< than Hs, therefore use eq. for Deep Bins
Overpressure Factor, F =	1.4	1.0 for shallow bins, 1.4 for deep bins

Use the spreadsheet on the following pages to calculate Grain Pressures and Wall Loads:

Static Vertical Pressure at depth Y, $V(Y) = (WR/\mu k)[1-e^{(-\mu kY/R)}]$ for deep bins <== eq. used

$= WY$ for shallow bins

Static Lateral Pressure at depth Y, $L_s(Y) = kV(Y)$

Dynamic Lateral Pressure at depth Y, $L_d(Y) = FL_s(Y)$

Shear Stress between vertical wall and grain at depth Y, $S_v(Y) = \mu L_d(Y)$

Vertical Wall Load per unit length of bin wall at depth Y, $P_v(Y) = [WY-V(Y)]R$ for deep bins <==eq. used

$= S_v(Y)*Y/2$ for shallow bins

Maximum Results from the spreadsheet on the following pages:

Maximum Static Vertical Pressure, V_{max} = 1650 psf

Maximum Vertical Wall Load, $P_{v\,max}$ = 10020 plf

Maximum Static Lateral Pressure, Vs_{max} = 825 psf

KC Engineering, P.C.

Project Name: 30' Diameter Hopper Analysis
Location: Sioux Steel
Subject: Grain Pressures and Wall Loads - 30' Diameter Hopper

Date: 8/8/2012
Project #: 61165
Designer: DJM

Depth Y	V(Y) (psf)	Ls (Y) (psf)	Ld (Y) (psf)	Sv (psf)	Pv (plf)
0	0	0	0	0	0
1	55	27	38	14	5
2	108	54	76	28	20
3	160	80	112	41	45
4	211	105	147	55	79
5	260	130	182	67	123
6	308	154	216	80	175
7	356	178	249	92	237
8	401	201	281	104	307
9	446	223	312	116	385
10	490	245	343	127	472
11	533	266	373	138	567
12	574	287	402	149	669
13	615	308	431	159	779
14	655	327	458	170	896
15	693	347	485	180	1021
16	731	366	512	189	1153
17	768	384	538	199	1292
18	804	402	563	208	1437
19	839	419	587	217	1589
20	873	437	611	226	1747
21	906	453	634	235	1912
22	939	469	657	243	2083
23	971	485	679	251	2259
24	1002	501	701	259	2442
25	1032	516	722	267	2630
26	1061	531	743	275	2823
27	1090	545	763	282	3023
28	1118	559	783	290	3227
29	1146	573	802	297	3436
30	1172	586	821	304	3651
31	1198	599	839	310	3870
32	1224	612	857	317	4094
33	1249	624	874	323	4323
34	1273	636	891	330	4556
35	1296	648	907	336	4794
36	1319	660	924	342	5035
37	1342	671	939	348	5282
38	1364	682	955	353	5532

KC Engineering, P.C.

Project Name: 30' Diameter Hopper Analysis
Location: Sioux Steel
Subject: Grain Pressures and Wall Loads - 30' Diameter Hopper

Date: 8/8/2012
Project #: 61165
Designer: DJM

Depth Y	V(Y) (psf)	Ls (Y) (psf)	Ld (Y) (psf)	Sv (psf)	Pv (plf)
39	1385	693	970	359	5786
40	1406	703	984	364	6044
41	1426	713	999	369	6306
42	1446	723	1012	375	6572
43	1466	733	1026	380	6842
44	1485	742	1039	385	7114
45	1503	752	1052	389	7391
46	1521	761	1065	394	7671
47	1539	769	1077	399	7954
48	1556	778	1089	403	8240
49	1572	786	1101	407	8529
50	1589	794	1112	411	8822
51	1605	802	1123	416	9117
52	1620	810	1134	420	9415
53	1635	818	1145	424	9716
54	1650	825	1155	427	10020
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
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0	0	0	0	0	0
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0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

KC Engineering, P.C.

Project Name: 30' Diameter Hopper Analysis		Date:	8/8/2012
Location: Sioux Steel		Project #:	61165
Subject: Wind Loads		Designer:	DM

Velocity Pressure on Wall:

$q_z = 0.00256*K_z*K_{zt}*K_d*V^2*I$

Velocity Pressure coefficient, K_z:	Varies per height	ASCE Table 6-3
Wind directionality factor, K_d:	0.95	ASCE Table 6-4

Design Force on Wall:

$F = 1.6*q_z*G*C_f*C_g*A_f$

Velocity pressure, q_z:	Found above	See Table Below for calulations
Force coefficient, Cf:	0.712	Linear interpolation of Figure 6-21 with h/D < 7
Projected Area normal to wind, Af:	30 ft²	For 1' increments

Velocity Pressure on Roof Middle:

$q_h = 0.00256*K_z*K_{zt}*K_d*V^2*I$

qh:	19.2 psf	
Mean Roof Height, h:	55.7 ft	$h = H_s + (r*\tan\theta)/2$ where $\theta = 30°$
Velocity Pressure coefficient, K_z:	1.12	ASCE Table 6-3 for mean roof height, h
Wind directionality factor, K_d:	0.95	ASCE Table 6-4

Velocity Pressure on Roof Edges:

$q_h = 0.00256*K_z*K_{zt}*K_d*V^2*I$

qh:	19.0 psf	
Mean Roof Height, h:	52.7 ft	$h = H_s + (r*\tan\theta)/2$ where $\theta = 10°$
Velocity Pressure coefficient, K_z:	1.11	ASCE Table 6-3 for mean roof height, h
Wind directionality factor, K_d:	0.95	ASCE Table 6-4

KC Engineering, P.C.

Project Name:	30' Diameter Hopper Analysis	Date:	8/8/2012
Location:	Sioux Steel	Project #:	61165
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Design Force on Roof: Positive sign corresponds to a force into the binwhile a negative sign is a force away from the bin

Windward Middle

Length of Section, Lwm :	17 ft	Lwm = r/cosθ where θ = 30°
Velocity pressure, qh :	19.2 psf	Found above
Gust effect factor, G :	0.85	ASCE Section 6.5.8.1 - Rigid Structure
Force coefficient, Cp :	0.20	ASCE Figure 6-6
Projected Area normal to wind, Af :	260 ft²	Af = 1/2*D*Lwm
Force on windward middle roof, Fwm :	0.8 kips	Fu = qz*G*Cp*Af
Horizontal Componet of Force, FHwm :	0.4 kips	FH = 1/2*Fwm
Vertical Componet of Force, FVwm :	0.7 kips	FV = (3)^.5/2*Fwm

Leeward Middle

Length of Section, Llm :	17 ft	Llm = r/cosθ where θ = 30°
Velocity pressure, qz :	19.2 psf	Found above
Gust effect factor, G :	0.85	ASCE Section 6.5.8.1 - Rigid Structure
Force coefficient, Cp :	-0.60	ASCE Figure 6-6
Projected Area normal to wind, Af :	260 ft²	Af = 1/2*D*Lwm
Force on leeward middle roof, Flm :	-2.5 kips	Fu = qz*G*Cp*Af
Horizontal Componet of Force, FHlm :	-1.3 kips	FH = 1/2*Flm
Vertical Componet of Force, FVlm :	-2.2 kips	FV = (3)^.5/2*Flm

Windward Edge

Length of Section, Lwe :	8 ft	Lwe = r/cosθ where θ = 10°
Velocity pressure, qz :	19.0 psf	Found above
Gust effect factor, G :	0.85	ASCE Section 6.5.8.1 - Rigid Structure
Force coefficient, Cp :	-0.18	ASCE Figure 6-6
Projected Area normal to wind, Af :	179 ft²	Af = ((π*r)/4 *Lwe)*2 x2 for both edges
Force on windward middle roof, Fwe :	-0.5 kips	Fu = qz*G*Cp*Af
Horizontal Componet of Force, FHwe :	-0.3 kips	FH = 1/2*Fwe
Vertical Componet of Force, FVwe :	-0.5 kips	FV = (3)^.5/2*Fwe

Leeward Edge

Length of Section, Lle :	8 ft	Lle = r/cosθ where θ = 10°
Velocity pressure, qz :	19.0 psf	Found above
Gust effect factor, G :	0.85	ASCE Section 6.5.8.1 - Rigid Structure
Force coefficient, Cp :	-0.70	ASCE Figure 6-6
Projected Area normal to wind, Af :	179 ft²	Af = (π*r)/4 *Lle x2 for both edges
Force on windward middle roof, Fle :	-2.0 kips	Fu = qz*G*Cp*Af
Horizontal Componet of Force, FHle :	-1.0 kips	FH = 1/2*Fle
Vertical Componet of Force, FVle :	-1.8 kips	FV = (3)^.5/2*Fle

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Project Name:	30' Diameter Hopper Analysis	Date:	8/8/2012
Location:	Sioux Steel	Project #:	61165
Subject:	Wind Loads	Designer:	DM

**Postive Moment means clockwise and
Negative Moment mean counter-clockwise

Vertical Load from Bridge:	0.0 kips		
Horizontal Load from Bridge:	0.0 kips		
Total Edge Length corner sections, ELc:	11.8 ft	Elc = (π/4)*r	per section
Total Edge Length on middle sections, ELm:	23.6 ft	ELm =(π*D - 4*ELc)/2	per section

Windward Middle

Vertical Componet of Force, FVwm :	0.7 kips	Found Above
Resultant vertical roof force, Vwm :	0.7 kips	Vwm = DLBR + FVwm
Distance from Centroid, Dvwm :	-7.5 ft	Dvwm = D/4
Moment:	-5.5 kip-ft	M = Vwm*Dvwm
Horizontal Componet of Force, HVwm :	0.4 kips	Found Above
Distance from Centroid, Dhwm :	55.7 ft	h (mean roof heigh found above)
Moment:	23.6 kip-ft	M = HVwm*Dhwm

Leeward Middle

Vertical Componet of Force, FVlm :	-2.2 kips	Found Above
Resultant vertical Force, Vlm :	-2.2 kips	Vlm = DLBR + FVlm
Distance from Centroid, Dvlm :	7.5 ft	Dvlm = D/4
Moment:	-16.5 kip-ft	M = Vwlm*Dvlm
Horizontal Componet of Force, HVlm :	-1.3 kips	Found Above
Distance from Centroid, Dvlm :	-55.7 ft	h (mean roof heigh found above)
Moment:	70.7 kip-ft	M = HVlm*Dhlm

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Project Name:	30' Diameter Hopper Analysis	Date:	8/8/2012
Location:	Sioux Steel	Project #:	61165
Subject:	Wind Loads	Designer:	DM

Windward Edges

Vertical Componet of Force, FVwe :	-0.5	kips	Found Above
Resultant Vertical Force, Vwe :	-0.5	kips	Vwe = DLss + Fvwe
Distance from Centroid, Dvwe :	-5	ft	Dvwe = D/6
Moment:	2.3	kip-ft	M = Vwe*Dvwe
Horizontal Componet of Force, HVwm :	-0.3	kips	Found Above
Distance from Centroid, Dvwm :	52.7	ft	h (mean roof heigh found above)
Moment:	-13.7	kip-ft	M = HVwe*Dhwe

Leeward Edges

Vertical Componet of Force, FVle :	-1.8	kips	Found Above
Resultant Vertical Force, Vle :	-1.8	kips	Vle = DLss + Fvle
Distance from Centroid, Dvle :	5	ft	Dvle = D/6
Moment:	-8.8	kip-ft	M = Vle*Dvle
Horizontal Componet of Force, HVle :	-1.0	kips	Found Above
Distance from Centroid, Dvle :	-52.7	ft	h (mean roof heigh found above)
Moment:	53.3	kip-ft	M = HVle*Dhle

Total Vertical Force, VT :	-4	kips	Sum Resultant on Roof and DLwalls : + is Down
Total Uplift Force, UT :	3.7	kips	If Positive Vertical Force, no uplift on bin
Total overturning moment, MT :	714	kip-ft	Sum of moments
Tension per Stiffener, Tu :	0.18	kips	Tu = UT/N N = number of stiffeners
Total Shear Force, Vu	18.7	kips	Sum Horizontal Forces

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Project Name: 30' Diameter Hopper Analysis		Date:	8/8/2012
Location: Sioux Steel		Project #:	61165
Subject: Wind Loads		Designer:	DM

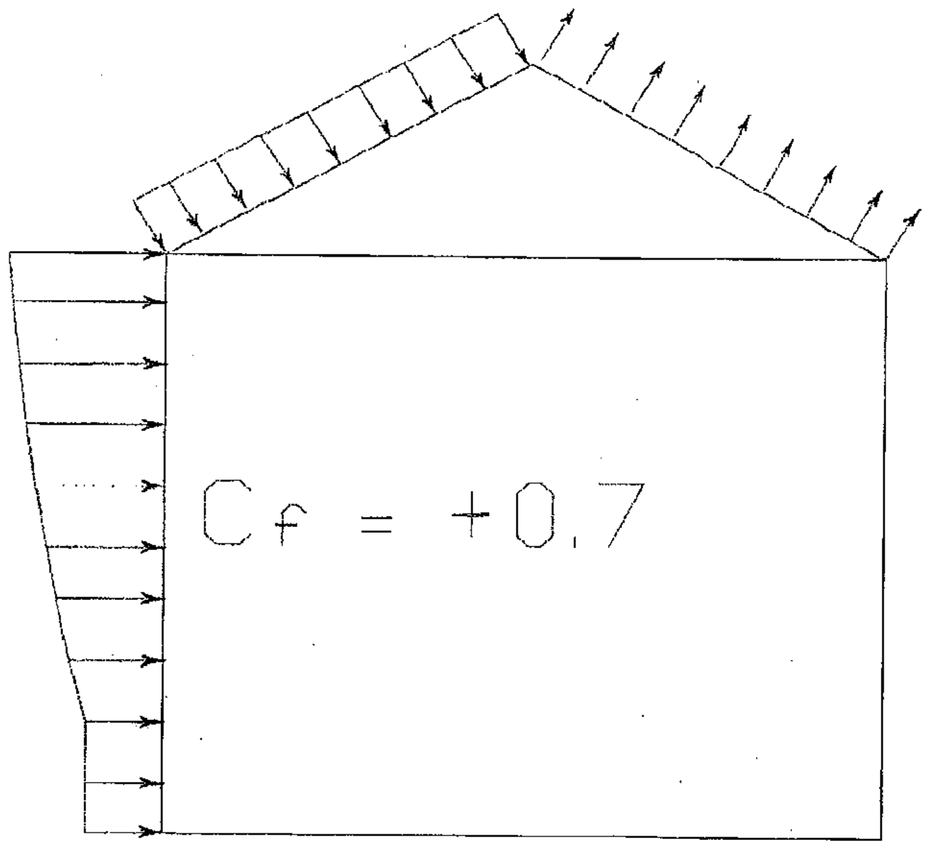
WIND FORCE ON SIDE WALLS

Height Z (ft)	Kz	qz (psf)	F (lbs)	F (klps)	Moment: F*Z (k-ft)
0	0.85	14.55	264	0.26	2.77
1	0.85	14.55	264	0.26	3.04
2	0.85	14.55	264	0.26	3.30
3	0.85	14.55	264	0.26	3.57
4	0.85	14.55	264	0.26	3.83
5	0.85	14.65	266	0.27	4.12
6	0.87	14.84	269	0.27	4.45
7	0.88	15.03	273	0.27	4.77
8	0.89	15.21	276	0.28	5.11
9	0.90	15.37	279	0.28	5.44
10	0.91	15.54	282	0.28	5.78
11	0.92	15.69	285	0.28	6.12
12	0.92	15.84	288	0.29	6.47
13	0.93	15.99	290	0.29	6.82
14	0.94	16.13	293	0.29	7.17
15	0.95	16.27	295	0.30	7.53
16	0.96	16.40	298	0.30	7.89
17	0.96	16.53	300	0.30	8.25
18	0.97	16.65	302	0.30	8.62
19	0.98	16.77	304	0.30	8.98
20	0.99	16.89	307	0.31	9.35
21	0.99	17.01	309	0.31	9.73
22	1.00	17.12	311	0.31	10.10
23	1.01	17.23	313	0.31	10.48
24	1.01	17.34	315	0.31	10.86
25	1.02	17.44	317	0.32	11.24
26	1.02	17.54	318	0.32	11.62
27	1.03	17.64	320	0.32	12.01
28	1.04	17.74	322	0.32	12.40
29	1.04	17.84	324	0.32	12.79
30	1.05	17.93	326	0.33	13.18
31	1.05	18.02	327	0.33	13.58
32	1.06	18.11	329	0.33	13.98
33	1.06	18.20	330	0.33	14.37
34	1.07	18.29	332	0.33	14.78
35	1.07	18.38	334	0.33	15.18
36	1.08	18.46	335	0.34	15.58
37	1.08	18.54	337	0.34	15.99

38	1.09	18.63	338	0.34	16.40
39	1.09	18.71	340	0.34	16.81
40	1.10	18.78	341	0.34	17.22
41	1.10	18.86	342	0.34	17.63
42	1.11	18.94	344	0.34	18.05
43	1.11	19.01	345	0.35	18.47
44	1.11	19.09	347	0.35	18.88
45	1.12	19.16	348	0.35	19.30
46	1.12	19.23	349	0.35	19.73
47	1.13	19.31	350	0.35	20.15
48	1.13	19.38	352	0.35	20.57
49	1.13	19.44	353	0.35	21.00
50	1.14	19.51	354	0.35	21.43
51	1.14	19.58	355	0.36	21.86

KC Engineering, P.C.

Project Name:	30' Diameter Hopper Analysis	Date:	8/8/2012
Location:	Sioux Steel	Project #:	61165
Subject:	Wind Loads	Designer:	DM



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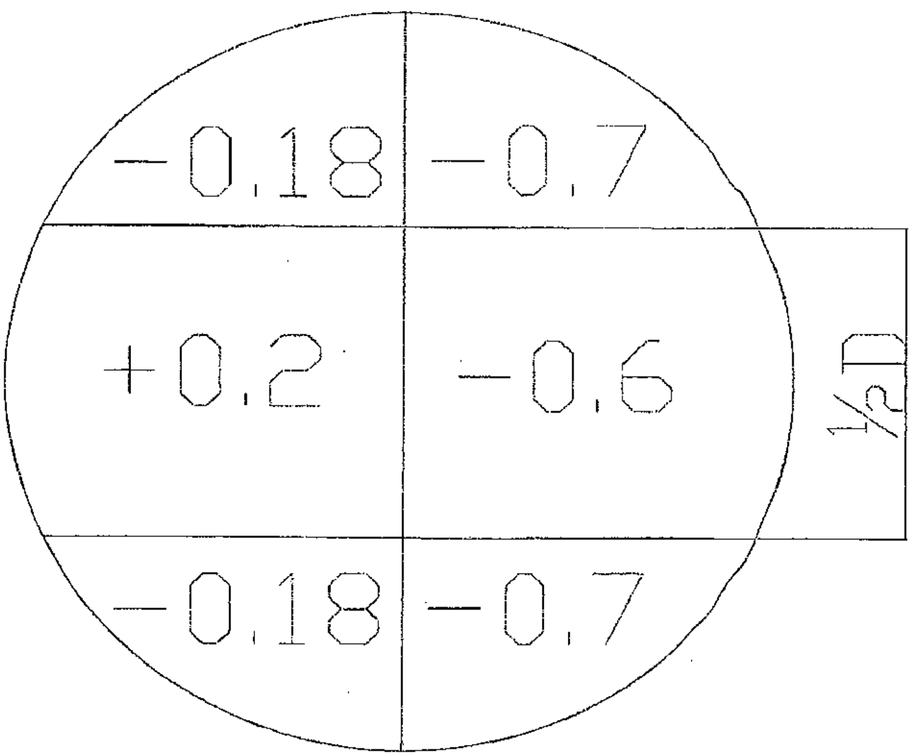
Project Name:	30' Diameter Hopper Analysis	Date:	8/8/2012
Location:	Sioux Steel	Project #:	61165
Subject:	Wind Loads	Designer:	DM

External Pressure Coefficients, C_p



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PROJECT NAME: 30' Φ Hopper Analysis	PAGE 1 OF 2	DATE: 8/13/12
LOCATION: Sioux Steel	PROJECT #: 61165	
SUBJECT: Column Code Check	DESIGNER: DM	

W8x28 : $A = 8.25 \text{ in}^2$

$r_x = 3.45 \text{ in}$

$r_y = 1.62 \text{ in}$

- Compressive Strength

$$\frac{KL_x}{r_x} = \frac{1.0\,(17\times 12)}{3.45} = 59.13$$

$$\frac{KL_y}{r_y} = \frac{1.0\,(8\times 12)}{1.62} = 59.26 \leftarrow \text{Controls}$$

$$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2} = 81.50$$

$$F_{cr} = \left[.658^{F_y/F_e}\right] F_y = \left[.658^{50/81.5}\right] 50 = 38.68 \text{ Ksi}$$

$$P_n = F_{cr} A_g = 38.68^{\text{Ksi}} (8.25 \text{ in}^2) = 319.11^{\text{Kip}}$$

$$\frac{P_n}{\Omega_c} = 191.1 \text{ kips}$$

- Moment Capacity

$$\frac{M_n}{\Omega_b} = 49^{\prime\text{-K}}$$ (Table 3-10) w/ $L_{bx} = 17 \text{ ft}$

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PROJECT NAME: 30' Ø Hopper Analysis	PAGE 2 OF 2	DATE: 8/13/12
LOCATION: Sioux Steel	PROJECT #: 61165	
SUBJECT: Column Code Check	DESIGNER: DM	

$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}}\right)$$

$P_r = 157.34^{\text{kips}}$

$M_{rx} = 30.05^{'-K}$

$$\frac{157.34}{191.1} + \frac{8}{9}\left(\frac{30.05}{49}\right) = \underline{\underline{1.37}}$$

$\boxed{\text{Not OK}}$

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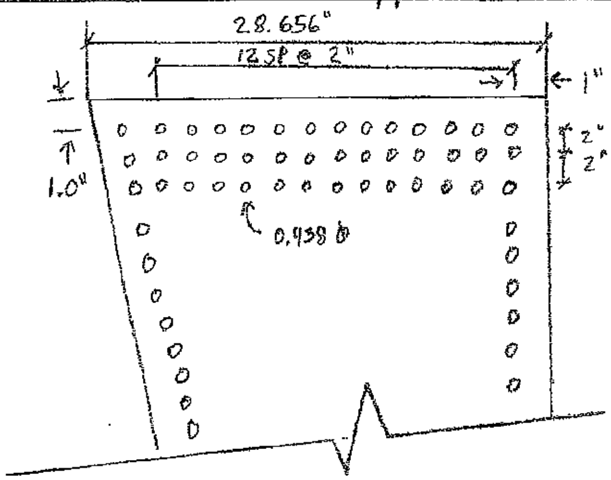
PROJECT NAME: 30' ϕ Hopper Analysis	PAGE 1 OF 3	DATE: 8/13/12
LOCATION: Sioux Steel	PROJECT #: 61165	
SUBJECT: Hopper Panel Connection	DESIGNER: DM	



Panel: 10 Ga, 50 Ksi

$F_y = 40.13 \frac{K}{ft}$ (RISA LC #2)

$T_u = 40.13 \frac{K}{ft} \left(\frac{28.656"}{12}\right)$

$= 95.83$ Kips

* Gross Section Yield

$R_n = F_y A_g$ (J4-1) where $\Omega_t = 1.67$.

$\frac{P_n}{\Omega_t} = \frac{F_y A_g}{\Omega_t} = \frac{50(28.656" \times .1345")}{1.67} = $ 115.4 Kips

* Net Section Fracture

$R_n = F_u A_e$ (J4-2) where $\Omega_t = 2.00$.

$A_e = U A_n$

$U = 1.0$ (Table D3.1)

$A_n = A_g - \Sigma A_h + \Sigma \frac{s^2}{4g} t$

$= 3.854 \text{ in}^2 - 14(.438 + 1/16)(.1345") = 2.912 \text{ in}^2$

$\frac{R_n}{\Omega_t} = \frac{65(1 \times 2.912)}{2.00} = $ 94.64 Kips ⟵ Controls

PLF 28

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	LOCATION: Sioux Steel	PROJECT #: 61165	
	SUBJECT: Hopper Panel Connection	DESIGNER: DM	

* Block Shear

$$R_n = 0.6 F_u A_{nv} + U_{bs} F_u A_{nt} \leq 0.6 F_y A_{gv} + U_{bs} F_u A_{nt} \quad (J4\text{-}5)$$

where $\Omega = 2.00$

- 1 Rows

$$A_{gv} = 14(1.0")(.1345") = 1.883 \text{ in}^2$$

$$A_{nv} = 14[1.0" - .5(.438 + 1/16)](.1345") = 1.412 \text{ in}^2$$

$$A_{nt} = 14[1.0' - 0.5(0.438 + 1/16)](.1345") = 1.412 \text{ in}^2$$

$$R_n = 0.6(65)(1.412) + 1.0(65)(1.412) = 146.8^K$$

$$\leq 0.6(50)(1.883) + 1.0(65)(1.412) = 148.3^K$$

- 2 Rows

$$A_{gv} = 14(3")(.1345") = 5.649 \text{ in}^2$$

$$A_{nv} = 14[3.0" - 1.5(.438 + 1/16)](.1345") = 4.235 \text{ in}^2$$

$$A_{nt} = 14[1.0" - 0.5(.438 + 1/16)](.1345") = 1.412 \text{ in}^2$$

$$R_n = 0.6(65)(4.235) + 1.0(65)(1.412) = 256.9^K$$

$$\leq 0.6(50)(5.649) + 1.0(65)(1.412) = 261.3^K$$

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	SUBJECT: Hopper Panel Connection	DESIGNER: DM	

• 3 Rows

$A_{gv} = 14(5")(.1345") = 9.415 \text{ in}^2$

$A_{nv} = 14(5" - 2.5(.438" + 1/16)](.1345") = 7.059 \text{ in}^2$

$A_{nt} = 14[1.0" - 0.5(0.438 + 1/16)](.1345") = 1.412 \text{ in}^2$

$R_n = 0.6(65)(7.059) + 1.0(65)(1.412) = 367.081^K$

$\leq 0.6(50)(9.415) + 1.0(65)(1.412) = 374.23^K$

→ Compare Rows

1. $\Sigma \gamma_i Q_i \leq \frac{R_n}{\Omega}$

$T_u \leq \frac{R_n}{\Omega}$

$\frac{R_n}{\Omega} = 14\left(\frac{P_u}{42}\right) - T_u$

$T_u = (1/3) P_u \leq \frac{R_n}{\Omega}$

$P_u = 3/1 \left(\frac{R_n}{\Omega}\right)$

$P_u = 3\left(\frac{146.8}{2}\right)$

$= 220.2^{\text{kips}}$

2. $\Sigma \gamma_i Q_i \leq \frac{R_n}{\Omega}$

$T_u \leq \frac{R_n}{\Omega}$

$\frac{R_n}{\Omega} = 28\left(\frac{P_u}{42}\right) - T_u$

$T_u = 2/3 P_u \leq \frac{R_n}{\Omega}$

$P_u = 3/2 \left(\frac{R_n}{\Omega}\right)$

$P_u = 3/2\left(\frac{256.9}{2}\right)$

$= 192.6^{\text{kips}}$

3. $\Sigma \gamma_i Q_i = \frac{R_n}{\Omega}$

$T_u \leq \frac{R_n}{\Omega}$

$P_u = \frac{367.0^K}{2}$

$= \underline{183.5^{\text{kips}}}$

∴ NSF Controls

<u>OK</u>

$\frac{R_n}{\Omega} = 94.6^{\text{kips}} \approx T_u = 95.3^{\text{kips}}$

$\frac{95.3}{94.6} = 1.007 \rightarrow 0.7\%$

Less than 2% therefore OK

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PROJECT NAME: 30' Φ Hopper Analysis	PAGE 1 OF 1	DATE: 8/13/1[illegible]
LOCATION: Sioux Steel	PROJECT #: 61165	
SUBJECT: Hopper Forces Results	DESIGNER: DM	

* Maximum Hopper Stress (LC # 2)

σ_{max} = 28.851 Ksi @ 1'-6" below top of hopper

$\sigma_{Allowable} = \frac{\sigma_Y}{\Omega} = \frac{50 \text{ Ksi}}{1.67} = 29.94 \text{ Ksi} > \sigma_{max}$

OK

* Maximum Base Reactions

- Max Reaction = 157.3 Kips (LC # 2)
- Max Uplift = -4.8 Kips (LC # 10)
- Max Base Shear = 2.17 (LC # 7)

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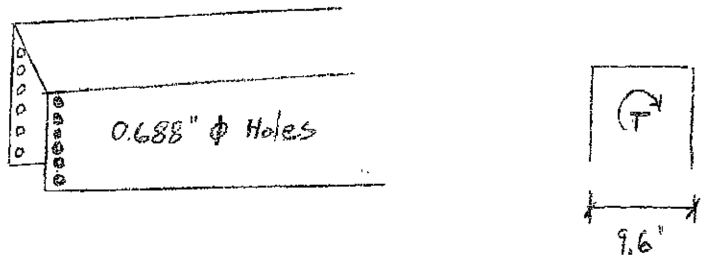
PROJECT NAME: 30' Φ Hopper Analysis	PAGE 1 OF 1	DATE: 8/13/12
LOCATION: Sioux Steel	PROJECT #: 61165	
SUBJECT: Comp. Ring Weldment Connection	DESIGNER: DM	

M_z of Column = $30^{\text{'-K}}$



* Loading

$T = 30^{K-ft}$

$M = V_1\left(\frac{H}{2}\right) + V_2\left(\frac{H}{2}\right)$ where $V_1 = V_2$

$30^{K-ft} = V\left(\frac{4.8''}{24}\right) + V\left(\frac{4.8''}{24}\right)$

$V = 75^{Kips}$

$V_1 = 37.5^K$

$V_2 = 37.5^K$

$V_u = 6.25\ ^K/Bolt$

* Bolt Shear

→ If A325 w/ Threads Included Bolts (5/8" ϕ)

$\frac{r_n}{\Omega} = 8.29\ \frac{K}{Bolt} > V_u$

OK

* Bearing

→ STD 5/8" ϕ

$\frac{r_n}{\Omega} = 34.1\frac{K}{in}$

$= 34.1\frac{K}{in}\left(\frac{5}{16}''\right) = 10.6$ Kips $> V_u$

OK